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(71) Applicant (for all designated States except US): **AUTOLIV DEVELOPMENT AB** [SE/SE]; S-447 83 Vårgårda (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SADARANGANI, Chandur** [SE/SE]; Högatan 5, S-724 66 Västerås (SE). **ARSHAD, Waqas** [PK/SE]; Alhagsgatan 76, 1 tr, S-145 59 Norsborg (SE). **BÄCKSTRÖM, Thomas** [SE/SE]; Engelbrektsgatan 13, S-722 16 Västerås (SE). **ÖSTLUND, Stefan** [SE/SE]; Bergsätravägen 22 A, S-181 61 Lidingö (SE).

(74) Agents: **KARLSSON, Leif** et al.; Groth & Co. KB, Box 6107, S-102 32 Stockholm (SE).

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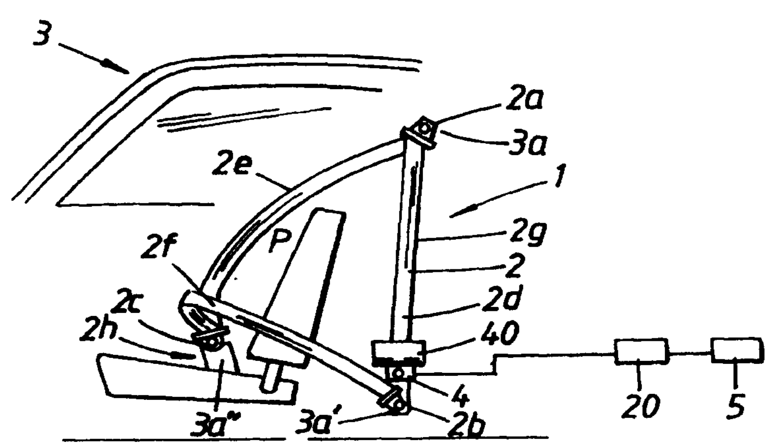
(54) Title: ARRANGEMENT RELATED TO SEATBELTS



(57) Abstract: The invention includes an arrangement related to seatbelts (1) adapted to a vehicle, having at all events two securing points (2a, 2b), intended for the belt, which points are related to a chassis (3a) belonging to the vehicle, at all events one of the securing points (2b) belonging to the belt consisting of a reel (40), drivable by an electric motor (4), in order to be able to reel belt sections or parts near the securing points (2d) thereon with an intention of being able to hold belt stretchings (2e, 2f) stretched against a person's chest and/or trunk portion or vice versa. One or more sensors are adapted to, at a value occurring above a selected limit value, let said electric motor (4) be activated to drive the reel (40) in a direction in order to increase the stretching force in said belt, and said electric motor consists of a polyphase motor. Said polyphase motor (4) is designed to present a low electric inductance and/or a high torque density, in order to thereby be able to provide a relatively high starting torque, high torque and endure high overload during intermittent operation conditions.

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ARRANGEMENT RELATED TO SEATBELTS

Technical Field of the Invention

The present invention generally relates to an arrangement related to seatbelts and more especially to an arrangement related to seatbelts adapted to a vehicle.

An arrangement related to seatbelts, according to the present invention, utilizes, at a vehicle application, at all events two securing points intended for the belt, which points are related to a chassis belonging to the vehicle, at all events one of the securing points belonging to the belt consisting of a reel, drivable in a rotary motion by an electric motor, in order to either be able to reel belt sections or portions near the securing points so as to, thereby, be able to keep the belt stretched against a person's chest and/or trunk portions or vice versa.

Arrangements of the relevant type also utilize one or more sensors. Sensors that here could be of use are adapted to be able to detect and/or assess one or more risk situations.

For the application shown here, it is common to have sensors utilized that are sensible to acceleration forces and that are adapted to, at a value occurring above a selected limit value, have said electric motor activated to drive the reel in a direction in order to reel belt sections and/or increase the stretching force in said belt.

The present invention is also based on having an electric motor utilized driven by alternating current. Here, it is suggested that the motor in that connection should be consisting of a polyphase motor.

Previous Prior Art

Arrangements related to seatbelts, of the nature mentioned by way of introduction, where one securing point belonging to the belt consists of a reel, which is drivable in a rotary motion by an electric motor and constructed for three-phase operation, are previously known in a plurality of different embodiment examples.

Thus, reference is made to previous prior art, which is shown and disclosed, in an international patent publication WO 99/51 469.

Here, an arrangement related to seatbelts is shown and disclosed, which

can present a reeling and a stretching of the seatbelt, where a frame structure (101), adapted to a reeling of belt parts or sections, is provided with or adapted to carry an electric motor (112), in order to thereby be able to stretch the belt to a comfortable degree, for normal conditions, as well as to adapted higher degrees, advantageous at occurring distress or emergency situations.

Here, the possibility is disclosed of letting the electric motor be activated as often as required and without, for this reason, no major measures for requisite maintenance being needed.

The energy that is required to drive the motor is obtained from a high-voltage capacitance (114), which is adapted to store energy sufficient for an occurring emergency situation. In that connection, the effect of the seatbelt will be entirely independent of the electric resistance in and to the starter battery of the vehicle, in which the seatbelt having the electric motor is mounted.

All electronic parts, such as those that are connected to the stator phases of the utilized alternating current motor and capacitances, are contained in a screened and protected casing (104, 119, 124), presenting only a low emission of high-frequency electromagnetic disturbances.

The electric motor is here mounted to a first end part of a shaft or reel (102), for a direct driving of said shaft and for being able to reel or unreel belt sections thereon.

The mounting of the individual mechanical parts and the chosen electric circuit, having sensors actuable by occurring acceleration forces (or retardation forces), is here made in such a way that the electric motor and the reel will be able to actuate the belt so that at a slack belt stretching, belt parts or sections will be reeled in order to obtain a belt stretching that by a small pressure will be able to abut against a person's chest and trunk portions, while at a collision the belt should, via an activation of the electric motor via a control circuit and a sensor, be reeled quickly with a very high belt stress, in order to hold the person against the seat during the remaining collision course.

Teeth members (120) may in that connection be arranged to have, in a known way, the rotor of the motor locked and thereby also the reel (102).

Signal processing and sensor sensitive circuits (108, 109, 107) adapted to low voltage signals, are placed within the casing (101d) attached to the opposite end of the reel.

Fig. 3 in said patent publication shows that a system voltage (12 V DC; 301) is supplied to a DC/DC converter (304), which in turn charges an energy absorbing capacitance (114), to a voltage of 450 V DC.

This voltage 450 V DC is via a circuit (113) feedable to a polyphase motor (112), which is suggested to be in the form of a brushless DC motor.

Summary of the Present Invention

Technical Problem

If the circumstance is taken into consideration that the technical considerations, which a person skilled in the art in the relevant technical field of the invention has to make in order to be able to present a solution to one or more presented technical problems, initially are a required insight in the measures and/or sequence of measures that should be taken as well as a necessary choice of the means or those means that are required and in view of this, the subsequent technical problems should be relevant at the production of the present subject of invention.

Considering previous prior art, such as the same has been disclosed above, it should stand out as a technical problem, at an arrangement related to seatbelts, adapted to a vehicle, of the nature mentioned by way of introduction, to be able to create such opportunities that an electric motor of the three-phase type utilized for a reeling (or unreeling) of belt sections, could be dimensioned and mechanically adapted so that a compact design well adapted to the purpose can be at hand.

There is also a technical problem in being able to realize the significance of and the advantages associated with having the motor designed for alternating current operation, where the supply voltage becomes directly related to an available system voltage, such as below 50 V DC.

Furthermore, it also appears to be considered as a technical problem to be able to create such opportunities that the motor can be constructed and designed for an intermittent operation, and thereby be dimensioned for an adapted and stated overload, at all events during the acceleration phase, and thereby have the reduction of the dimensions utilized that such an intermittent operation can pres??ent.

In addition, it should be seen as a technical problem to be able to realize

the significance of and the advantages associated with having a chosen miniaturization be driven so far that the restriction at utilized overload is to be related to phenomena that would cause a temperature-dependent demagnetisation of permanent magnets belonging to the motor, caused by occurring counter-directed magnet fields generating in windings belonging to the stator or reach a thermal limit of utilization of the winding insulation.

In addition, it should be seen as a technical problem to be able to realize the significance of and the advantages associated with still being able, in spite of a compact design, to create such opportunities at the motor construction that the motor primarily will be able to relatively quickly present a high torque at a connection of the electric motor to an alternating voltage that is generated from a normal operation or system-assigned voltage.

There is a technical problem in being able to present a motor construction that becomes adapted to have a high starting torque, a high continuous torque and/or present a high overload without having to take particular consideration to construction measures that aim at achieving a high efficiency of the motor.

Then, there is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be constructed and designed so as to, at a direct connection to an alternating voltage and with the rotor stationary, be able to have a low electric inductance so as to thereby be able to create favourable opportunities for being able to provide relatively high starting current derivative, as well as a high torque density in order to acquire a smaller volume and a smaller consumption of material.

Thereby, it is a technical problem to be able to realize the significance of and the advantages associated with being able to create such opportunities that, in spite of the fact that the electric motor should be pre-connected by an electric circuit in the form of a DC/AC converter, ensure that said DC/AV converter also has a low inductance/resistance, so as to thereby being able to present a high supply voltage and high starting current derivative to the motor during the starting sequence.

There is also a technical problem in being able to realize the significance of and the advantages associated with having a DC/polyphase-AC converter utilized, which also has a low electric inductance/resistance, and which thereby creates opportunities for a low voltage drop attributed to the converter at the high

starting currents and high starting current derivative and where a DC/AC conversion is allowed to take place without or substantially without an appreciable voltage alteration.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor, for a reduction of the electric inductance, be designed with a relatively large air gap between stator and rotor, related to the size of the electric motor and volume-adapted to the application mentioned here.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the air gap be chosen to a well adapted value, where said value independently of the chosen motor construction should be below 3 mm.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting a selected air gap be chosen to a value within the range of between 0,7 and 1,4 mm.

Then, it is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor, for the same purpose as above, be designed with relatively few turns of a winding in the stator, taking into consideration, among other things, that the number of turns of a winding becomes strongly dependent on the chosen alternating voltage.

Then, it is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor, for the same purpose as above, be designed with permanent magnets belonging to the rotor.

It is a technical problem in being able to realize the significance of and the advantages associated with letting each one of said permanent magnets be allotted the form of a part of a hollow cylinder and where all the requisite permanent magnets are co-ordinated side by side in order to thereby form a complete hollow-cylindrical shape.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the permanent magnets be fixedly related to an inner surface portion of a hollow-cylindrical ring surrounding the permanent magnets at the construction of an inverted machine.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the ring consist of an iron or steel

material.

It is a technical problem in being able to realize the significance of and the advantages associated with letting the ring consist of a pressed and/or in another corresponding way formed iron powder material and/or steel material.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the radial thickness of a utilized ring be chosen to a ratio determined in advance in relation to said permanent magnets in order to be able to comply with the requirements that will be made on a motor construction adapted to the relevant application.

Then, it is a technical problem to be able to realize the significance of and the advantages associated with in the rotor having formed and utilized only such permanent magnets that have a high energy density and that have been formed in order to be able to orientate the same near the air gaps.

It is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be designed as an outer rotor machine, where the outer cylindrical surface of the rotor advantageously directly can be adapted to serve as a reel for belt parts.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting each one of a number of permanent magnets, included in a motor having an inner rotor, be allotted the shape of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to, in that connection, be able to form said hollow-cylindrical shape.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the permanent magnets be fixedly related to an outer surface portion of a hollow-cylindrical ring clamping the permanent magnets.

It is a technical problem in being able to realize the significance of and the advantages associated with letting the ring consist of an iron or steel material.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the ring consist of a pressed and/or in another and/or corresponding way formed, such as injection-moulded, iron powder material and/or steel material.

It is a technical problem in being able to realize the significance of and the advantages associated with letting the radial thickness of the ring be chosen to a

ratio determined in advance in relation to the radial thickness of the permanent magnets in order to thereby present a design of the motor that complies with the requirements that should be made on motors for the application disclosed here.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the ratio be chosen within rather narrow limits.

In that connection, there is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be divided into two motor units, arranged electrically parallel, one on each side of a shaft or a reel.

It is a technical problem in being able to realize the significance of and the advantages associated with having a control unit disclosed, which is adapted in order to detect at all events one, such as the changed state of a number of sensors and guided thereby have the electric motor activated in order to reel or unreel belt portions and where chosen reeling sequences advantageously could to be made with different belt stretching tensile forces.

In addition, there is a technical problem in being able to realize the significance of and the advantages associated with that also at such a compact electric motor as the invention discloses let the rotor and stator be allotted such a mutual orientation that at an abruptly applied current increase, of a high supply current derivative, a maximised or an approximately maximised torque is obtained via the stator currents.

In addition, there is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor present that one or more, such as all, parts within a rotor and/or stator consist of pressed or in a corresponding way formed iron powder.

It is a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor present that one or more, such as all, parts within a rotor and/or a stator consists of solid metallic material, such as constructed using a solid using a hollow-cylindrical part as a basis, where said part advantageously may consist of an iron material or a steel material.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be designed for a chosen short time load.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the chosen short time load be based on a selected number of, such as three, short maximal power outputs within a duration determined in advance, such as below 5 min.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the maximal torque output be limited to a chosen duration, such as 0,5 s.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the polyphase motor be, via mechanical gear equipment, in a co-operation with the reel.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the polyphase motor and the reel be oriented as branches in a U-shaped unit having a gear equipment connecting said branches.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be constructed for a relatively high number of revolutions and that the motor thereby may be constructed with small outer dimensions and present a compact construction in other respects.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the chosen high number of revolutions exceed 2 000 revolutions per minute.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting said polyphase motor be constructed and designed, taking requirements for compactness, high torque density etc., into consideration and realizing that the construction and the design in this connection may be effected without taking impact of iron losses into consideration.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the high torque density be chosen to exceed 8 Nm/kg.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the upper limit of the chosen torque density be chosen somewhat below a set temperature-dependent demagnetisation limit of utilized permanent magnets or a thermal limit of utilization of the winding

insulation.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting such measures be taken that said polyphase motor can be allotted a reduced slot insulation within the stator, in order to thereby be able to present an increase of available winding area and increase the filling ratio of the windings within the stator.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the stator be moulded and/or injection moulded from a powder material in order to, in that connection, provide smooth surfaces and in that connection be able to increase the filling ratio of the windings.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting a wire be utilized as winding wire, having a wire cross-section that may present a high packing degree, such as a wire having a right-angled cross-section.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the high power density be based on a chosen current load upwards approaching 1 200–2 500 A/cm^2.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting the force density be chosen to between 0,1–0,3 N/mm^2 air gap surface.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting one or more of utilized risk-sensing and/or risk-evaluating sensors be adapted to have vehicle-internal and/or vehicle-external obstacles detected and have different functions related to one or more sensors initiated.

It is also a technical problem in being able to realize the significance of and the advantages associated with letting one or more of available risk-sensing and/or risk-evaluating sensors be adapted to detect and evaluate motions attributed to the vehicle, within a three-dimensional motion pattern.

In addition, it should be seen as a technical problem to be able to realize the significance of and the advantages associated with letting risk-sensing and/or risk-evaluating sensors be utilized that are adapted to be able to detect the changed state of the chassis, such as rotation and/or acceleration around different vehicle-assigned main axes and/or that are arranged to be able to detect vehicle-

external phenomena, such as the utilization of radar equipment.

The solution

Thus, the present invention is based on an arrangement related to seat-belts, adapted to a vehicle, having at all events two securing points, intended for the belt, which points are related to a chassis belonging to the vehicle, at all events one of the securing points belonging to the belt consisting of a reel, drivable to a rotary motion of an electric motor, in order to be able to reel belt sections or portions near the securing points thereon, with an intention of thereby being able to hold belt stretchings stretched against a person's chest and/or trunk portion or vice versa.

One or more sensors, adapted to be able to detect and/or assess one or more risk situations, for instance such as sensors sensible to acceleration forces, are adapted to, via a control circuit, at a value occurring above or below a selected limit value, let said electric motor be activated to drive the reel, by a chosen high torque, in a direction for letting the stretching force in said belt stretchings be increased, at which said electric motor for this purpose should consist of a polyphase motor.

In order to be able to solve one or more of the above-mentioned technical problems, the present invention now discloses that said polyphase motor should be adapted to and designed for stationarily having a low electric inductance and a high torque density, in order to thereby be able to relatively quickly provide a high torque from an applied voltage generated by a system voltage via a DC/AC converter, where the AC voltage agrees with an alternating voltage corresponding to the system voltage.

As proposed embodiments, falling within the scope of the present invention, it is disclosed that said motor for this purpose could be designed with a relatively large air gap.

Furthermore, it is disclosed that the air gap could be selected to a value that is below 3 mm or to a value that at all events is selected to exceed 0,5 mm.

The air gap may be selected to a value between 0,7 and 1,4 mm.

Furthermore, it is disclosed that said polyphase motor for this purpose could be designed with relatively few turns of a winding per phase within the stator.

Here, it is suggested that the number of turns in the stator belonging to the polyphase motor should be selected to be below 40.

However, the number of turns in the stator may be chosen to as few as one but in the practical application, the number should be able to exceed 2-4 turns per phase.

The number of turns in the stator, using an alternating voltage directly related from a nominal direct-current voltage of below 50 V DC, is selected to be below 40.

Each one of said permanent magnets is allotted the shape of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to, in that connection, form said hollow-cylindrical shape.

The permanent magnets are fixedly related to an inner surface portion of a hollow-cylindrical ring, surrounded by the permanent magnets.

The ring may consist of an iron or steel material.

More especially, it is disclosed that the number of turns in the stator is selected to exceed four turns per phase.

The radial thickness of a utilized ring is allotted a ratio to the radial thickness of the utilized permanent magnets determined in advance.

Furthermore, it is disclosed that said polyphase motor could be constructed for and designed with a number of permanent magnets of high energy density, distributed close to the air gaps within the rotor.

Furthermore, the polyphase motor is designed as an outer rotor machine, where the peripheral cylindrical surface of the rotor is adapted to be able to serve as a reel for reeling and unreeling belt portions.

Each one of a number of permanent magnets, included in a motor having an inner rotor, is allotted the shape of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to form said hollow-cylindrical shape.

The permanent magnets are fixedly related to an outer surface portion of a hollow-cylindrical ring clamping permanent magnets. The ring consists of an iron or steel material.

The ring consists of a pressed and/or in another way formed, such as casted iron powder material and/or steel material.

Furthermore, the polyphase motor may be divided into two motor units, ar-

ranged electrically parallel, one on each side of a shaft serving as said reel.

In addition, it is disclosed that a control circuit should be adapted in such a way that it can detect a changed state of a number of sensors and guided thereby have the electric motor activated in order to reel or unreel belt portions.

Furthermore, the control circuit may be adapted to allot the rotor and the stator such a mutual orientation that an applied current increase of a high current derivative via the stator currents provides a maximised torque or at all events substantially maximised torque.

Furthermore, the invention discloses that said polyphase motor should have a rotor or a stator, which may be constructed using a solid hollow-cylindrical part as a basis.

Here, it is disclosed that one or more, such as all, parts within a rotor and/or a stator may consist of a solid metallic material and/or one of iron powder compressed metallic material.

Furthermore, it is disclosed that said polyphase motor is designed for a short time load where the chosen short time load is based on a number of short maximal power outputs within a duration determined in advance. It is suggested that the maximal power output can be limited to a duration determined in advance of, say, 0,5 s.

The polyphase motor is via a mechanical gear equipment in co-operation with the reel where the polyphase motor and the reel are oriented as branches in a U-shaped unit, having a gear equipment connecting said branches.

Said polyphase motor is constructed for a high number of revolutions and gets, in doing so, a compact construction. The chosen high number of revolutions should exceed 2 000 revolutions per minute.

Furthermore, it is disclosed that said polyphase motor could be designed without needing to take into consideration, at least not to any major extent, the existence of iron losses.

A requisite high torque density is chosen to exceed 8 Nm/kg.

The upper limit is chosen somewhat below a set temperature-dependent demagnetisation limit of utilized permanent magnets or a thermal limit of the winding insulation.

Said polyphase motor may advantageously be allotted a reduced slot insulation within the stator, for an increase of the winding area and the filling ratio

or fill factor in the slots within the stator.

The stator is moulded and/or formed by a powder material in order to, in doing so, be able to increase the fill factor of the windings in the slots.

As winding wire, a wire cross-section of a high packing degree is utilized, such as a wire having a right-angled cross-section.

The high torque density is based on a chosen current load of up to 1 200-2 500 A/cm.

The torque is selected to between a 0,1–0,3 N/mm^2 air gap surface.

One or more sensors are adapted to by themselves being able to detect obstacles or another hazard.

One or more sensors are adapted to be able to detect motions attributed to the vehicle within a three-dimensional motion pattern.

Advantages

The advantages that foremost can be regarded as being characteristic of an arrangement related to seatbelts, according to the present invention, are that, in this way, opportunities have been created for being able to utilize a permanent magnetized polyphase motor, which not only is compactly dimensioned but furthermore can have a low electric inductance and a high torque density.

Furthermore, the electric motor should, by a system-assigned voltage, such as below 50 V DC, be able to provide a relatively quick high torque at a connection and by a chosen system voltage with the motor connected in series with a DC/AC converter.

What foremost can be regarded as being characteristic of an arrangement related to seatbelts, according to the present invention, is stated in the characteristic part subsequent of claim 1.

Brief Description of the Drawings

A presently suggested arrangement related to seatbelts, adapted to a vehicle, having the significative features associated with the present invention, will now for an exemplifying purpose be closer described with reference to the accompanying drawing, where;

Fig. 1 shows the arrangement related to seatbelts schematically and fastened to a chassis of a vehicle,

Fig. 2 schematically shows in the form of a block diagram a control circuit, adapted to being able to actuate a three-phase motor utilized according to the invention depending on obtained values from one or more sensors, so that it more or less adapted will be able to stretch said belt and its belt stretching around a person's chest and/or trunk portions,

Fig. 3 shows a force/time diagram (A) in order to illustrate occurring forces acting from the electric three-phase motor on the belt stretching during a collision sequence, where the force effect on the belt stretchings caused by the collision is not shown, and a torque/time diagram (B) of the relation of the torque to a chosen electric inductance, being in accordance with a three-phase motor according to the present invention,

Fig. 4 shows the principle for an outer rotor machine, adapted to be able to reel or unreel belt sections from a reel by an allotted rotary rotor motion,

Fig. 5 shows an outer rotor machine in an end view,

Fig. 6 shows one quarter of an outer rotor machine somewhat enlarged, in order to thereby be able to make clear features associated with the invention,

Fig. 7 schematically shows an embodiment where a utilized three-phase motor should be regarded as divided into two motor units, arranged electrically parallel, one on each side of a shaft or a reel and where the same in common should drive the reel in order to reel or unreel belt sections,

Fig. 8 shows in an end view and in a section a motor unit having an inner rotor and an outer stator utilized in fig. 7,

Fig. 9 shows an arrangements having a motor according to the present invention co-ordinated by a reel of a U-shaped unit and

Fig. 10 shows a cross section of a stator tooth having a concentric winding in two embodiments.

Description of the now proposed embodiment

With a reference to fig. 1, there an arrangement related to seatbelts 1 and adapted to a vehicle is thus shown, having at all events two (here illustrated as three), securing points intended for the belt, designated 2a, 2b, 2c, and with the reference designation 2 allotted to the belt.

The securing points 2a, 2b and 2c represent a three-point suspension or fastening and are related, as directly or indirect fastened, to a chassis portion

belonging to the vehicle 3, where the securing point 2a co-operates with the chassis portion 3a, the securing point 2b co-operates with the chassis portion 3a' and the securing point 2c co-operates with the chassis portion 3a".

The principles of the invention can of course be of use also at other seatbelt fastenings and other seatbelt stretchings than the one illustrated here.

At all events one of the three securing points belonging to the belt, in fig. 1 illustrated as 2b, consists of a reel 40, drivable in a rotary motion by an electric motor 4, in order to be able to reel belt sections or parts, designated 2d, near the securing points, around the peripheral cylindrical surface of the reel.

At an opposite motion of turning of the reel 40, belt sections or parts are, of course, unreeled.

The seatbelt stretching or the orientation in fig. 1 may be regarded as consisting of partly a first belt stretching 2e, oriented across a person's "P" (not shown) chestportion, partly a second belt stretching 2f, oriented across the persons trunk portion, and partly a third belt stretching 2g from the securing point 2a to the reel 40 and the motor 4.

By this reeling possibility, the belt stretchings 2e, 2f may be held stretched by different chosen forces towards a person's "P" chest and/or trunk portions or vice versa.

The motor 4 is controlled into the rotary motion thereof by a control unit 20, which in turn is actuable by a sensor 5 to an activated or deactivated position.

One or more sensors, each one adapted to be able to detect and/or assess a risk situation relevant for the application stated here, is in the following with a simplifying purpose illustrated as a sensor 5 sensitive to acceleration forces (retardation forces).

Said sensor 5 is adapted to, via the control circuit 20, let the electric motor 4 be controlled to different degrees of tensile forces in the belt 2 and the individual belt stretchings 2e, 2f, however, primarily, the belt stretching 2e via the belt stretching 2g.

Fig. 2 illustrates that four different sensor units 5a, 5b, 5b' and 5c are connected to a control unit 20.

The same may mutually be equal, but in the subsequent description, the significant characteristics of the invention will be described more in detail by assuming that said sensors have been allotted the function that each one reacts

on different elements of risk.

The sensor unit 5a will be of a more prominent importance for the present invention.

In this regard, the sensor unit 5a is adapted to, at an acceleration force value occurring above a selected limit value, let said electric motor 4 be immediately activated via the control unit 20 in order to thereby be able to drive the reel 40 in a direction to quickly let the stretching force in said belt stretchings 2g, 2e be increased to a maximised value of, say, above 100 N.

The sensor unit 5b is adapted, at a lower acceleration force value, to let said electric motor 4 be activated in order to be able to drive the reel 40 in a direction to increase the stretching force in said belt stretchings 2g, 2e to a value that is different from the stated maximal value and adapted lower than that value, such as a chosen low value of, say, 2-100 N.

Said sensor unit 5b is intended to be able to initiate a prestretching of the belt stretchings 2g, 2e before the sensor unit 5a would be activated for an initiation of an additional belt stretching.

As sensor units, such that are adapted to detect and/or assess the changed state of the chassis of a vehicle may be connected here. Here, such motions are primarily referred to that may be perceived as rotary motions, acceleration forces, retardation forces and other forces that occur when the vehicle turns around different allotted axes of rotation.

As sensor units, in this case it is possible to connect such that can detect and/or assess external conditions. Here, different types of radar equipments are suggested.

Connections of various sensors, which are adapted to detect and/or assess and/or determine a risk situation without the construction and/or function thereof being explicitly mentioned in this application, are within the scope of the invention.

The functions of the sensor unit 5b could also be co-ordinated by a sensor unit 5b' mentioned here, such as distance-measuring sensors, chassis-inclination sensors and the like.

An additional sensor unit 5c is shown and the same is connected to a belt lock 2h, so that when said lock is made loose, the reel 40 can, via the electric motor 4 and the control unit 20, reel the belt stretchings 2e, 2f hanging loosely

thereat.

The sensor unit 5a could also, via the control circuit or the control unit 20, be connected for a release of one or more airbags 21.

As for the utilized motor and its construction, it may be mentioned that the invention is based on the utilization of a polyphase motor driven by alternating current.

Even if a plurality of different motor constructions is within the scope of the invention, it may, however, be mentioned that it should in practice be advantageous to choose a motor construction having only a few phases.

Here, it may then be mentioned suitable motor constructions that can be driven by alternating voltages co-ordinated to two-phase, three-phase or four-phase.

The subsequent description will exemplify the invention by letting a three-phase motor 4 be utilized.

Three-phase motor 4 is, according to the disclosures of the invention, designed to being able to present a low electric inductance occurring at periods of rest, in order to in that connection being able to relatively quick provide a high torque, by being able to afford high stator current derivative at the moment of starting and retain high stator currents during the acceleration cycle of the motor and at a subsequent high load.

The low electric inductance is, in that connection, also advantageous at subsequent torque load and/or overload, since it also contributes to decreasing the demagnetisation effect from the stator current.

The motor construction should in other respects entirely focus on achieving a small volume, present a high torque and a high torque density and furthermore as low an inductance value as possible without too heavily sticking to other criteria that are to be related to normal motor constructions. In order to optimise low inductance and small volume, at a stated high torque, one can follow the flow chart according to fig. 2B.

Inductance values considerably below 10 mH are required for this application. Preferably, inductance values should be less than 0,4 mH but values downwards approaching 0,15 mH are of course even better.

With a reference to fig. 2, there it is shown that the starting current is generated by the system voltage of, say, 42 V DC, and is supplied via a DC/AC con-

verter 20a to the motor 4. Here, the three generated alternating currents are allotted a square-like or sine-like curve shape and are generated phase-shifted 120° according to the three-phase-system.

Fig. 2 also intends to illustrate the utilization of one additional electrical connection arrangement, and where the individual functions are illustrated in the form of blocks, in order to be able to control the motor 4, depending on indications from one or more sensor units 5a, 5b, 5b', 5c, to provide different stretching forces acting on the belt stretchings 2e, 2f and 2g, depending on different conditions.

The control unit 20 has, in that connection, the previously stated DC/AC converter 20a, which is controllable by a module 20b to drive the motor 4 in four different modes.

The module 20b should, depending on received control signals, have the electric motor 4 and the reel 40 activated in the following modes;

a) via the sensor 5a, a quick activation takes place, where full system voltage (say nominally 42 V DC) is immediately connected, for a conversion to alternating current as three-phase, in order to generate a maximum stretching force on the belt portion 2g of, say, above 100 N,

b) via the sensor 5b, an adapted lower activation takes place, via a reduced system voltage and/or current limiter, for a considerably less stretching force on the belt portion 2g of, say, 2-100 N,

c) via the sensor 5b', an adapted lower activation takes place according to "b" above and

d) via the sensor 5c, a total reeling of long belt stretchings 2e, 2f takes place.

The evaluations of these sensor-related signals take place in a block 20c.

The present invention primarily includes the activation that should take place at such an intense collision that will generate high acceleration force values (in the sensor 5a) and where immediate and quick measures should be taken in order to quickly be able to reel a loosely applied belt stretching as well as then have the belt stretchings 2e, 2f via 2g stretched, to a value determined in advance, in order to thereby be able to hold the chest and/or trunk portions of a person fixed in relation to the chassis 3.

With a reference to fig. 3, there a force/time diagram (A) valid for the invention and activated by the sensor unit 5a is shown, where the pulling force in

the belt stretching 2g (and 2e as well as 2f) during an initial stage is assumed to be absent, since loose belt stretchings are reeled thereunder, and then from the point of time "t1", the force "F" will increase by a rise rate that becomes dependent on the electric inductance value to a maximised value at the point of time "t2".

At lower inductance value (di/dt = U/L) of "L", the rise rate becomes higher or greater than at higher values, shown with dashed lines for the lower inductance value.

Forces on the belt stretching 2g reach the maximum value thereof at the point of time "t2", which can be adapted, depending on the motor construction 4, to between 100-500 N.

Also in fig. 3, a torque/time diagram (B) is shown of the utilized electric motor 4, where also here a lower inductance value provides a higher or greater rise rate than at a higher inductance value.

Thus, different motor constructions 4 will give different rise rates, depending on chosen dimensions and inductance values related thereto.

With a reference to fig. 4, the construction of an outer rotor machine 41 is there schematically shown, where the outer cylindrical surface 42' of the rotor 42 serves as a reeling surface (40) for the belt part 2d.

Thus, figs 4, 5 and 6 show that a belt part 2d is reelable and unreelable from the rotor 42 belonging to the motor 41.

A stator 43, having a centrally oriented shaft 43a, carries the requisite windings 43b.

Rotor 42 has a solid hollow-cylindrical shape, having a serving pipe-like magnetic flow conductor 42b of iron or other metallic material, also serving as protection, which also serves as a holder or the corresponding for a number of permanent magnets, where one has been allotted the reference designation 42a.

The pipe-like protection 42b and a number of permanent magnets 42a, 42a' ..... co-ordinated thereto constitutes the rotatable part. Bearing members intended for the rotation are not shown.

The reference designation 43a indicates not only a shaft belonging to the stator 43 but also a connecting shaft between end-related discs 44a, 44b.

Thus, in this embodiment it is shown in fig. 5 that eight permanent magnetizing magnets, two of which have been allotted the reference designations 42a, 42a' are placed as a hollow cylinder and connecting closely against the inside of

the hollow-cylindrical protection consisting of iron, serving as a flow-surrounding back 42b.

Thus, the stator 43 consists of a centrally oriented shaft 43a, a hollow-cylindrical part, denominated back, 43c, oriented around the shaft 43a.

Windings 43b are arranged between wings 43d, 43d' and in a fan-like way evenly distributed around the part or back 43c.

The slots between the stator teeth 43d, 43d' are in the figures drawn in with an angular cross-section, but in practice said slots are formed with a different cross-section. Here, the cross-section should be chosen so that it can accommodate the requisite winding wires, co-ordinated to the chosen number of turns. A plurality of winding wires may be co-ordinated in parallel in order to form the desired turns.

Furthermore, an air gap 44 is present between the stator part 43 and the permanent magnets (42a, 42a') and which air gap 44 is adapted and designed to provide the motor construction the intended criteria.

The magnetic (or effective) air gap "a", which includes properties of the magnets, should exceed 8 % of the air gap radius.

The embodiment according to figs 4, 5 and 6 is directly connected and adapted to a belt application according to the present invention.

Thereby, it may easily be exchanged against a conventional belt spindle and belt parts 2d can thereby directly be guided over the movable rotor 42 and be wound around the same.

Nor will any problems with the end windings need to arise since the space 46, 46a between the spring discs 44a, 44b described here will be available to surround the same.

The embodiments according to figs. 5 and 6 of the motor 41 are designed for an operation during very short periods.

Thus, it will be possible to load the motor 41 with very high flows, considerably higher than at continuous operation, as long as the thermal overheating within the stator 43 is eliminated and that the demagnetisation limits of the magnets 42a belonging to the rotor are respected.

Furthermore, it may mentioned that the maximum heat concentration is generated by low-resistant conductor material belonging to the windings 43b, such as copper conductor, and this is especially true by virtue of the thermal conditions

within the stator 43.

With a reference to fig. 7, there an arrangement is shown where said three-phase motor 71 should be regarded as divided into two motor units 72, 73, co-ordinated electrically parallel, one on each side of said reel (40), where the band section 2d is reelable via a spindle or a shaft 71a.

The spindle 71a co-operates with a motor unit 72, 73 each, which units are identically equal, and therefore only the motor 73 will be described.

In fig. 7 is, in that connection, furthermore seen that a rotor 74 is turnably arranged within a stator 75, which is fixedly related to the chassis and the securing points 3a'.

According to figs. 7 and 8, the stator 75 consists of a hollow-cylindrical casing or back 75b of metal and said casing or back surrounds windings 75c having appurtenant teeth 75d, 75d'.

Furthermore, there is an air gap 76 in the direction of the inner rotor 74 having a hollow-cylindrical permanent magnet set 74a co-operating with a back 74b.

Said rotor 74 carries a number of permanent magnets close to the air gaps, one of which has been allotted the reference designation 74a.

The invention includes the embodiment that at one or two utilized three-phase motors 4, (41; 72, 73), at a choice of a high revolution of each one, a small torque of each one may be accepted, however for this a gear unit is required.

Such an embodiment is presently most proposed and is illustrated in perspective view in fig. 9.

However, nothing prevents having three-phase motor 4 constructed and designed for a low number of revolutions of a high torque and in that connection create opportunities for a direct driving of belt section 2d.

For this application, here the torque may be chosen to between 2 Nm and approx. 10 Nm.

The disclosed three-phase motor 4 (41; 72, 73) may have one single winding per phase and in principle, only a few turns are required, due to the fact that the motor should be driven by a voltage below 50 V DC.

The numbers of turns may here be chosen with a number adapted to a chosen three-phase system voltage.

The permanent magnets 42a, 74a should be of a type having a high

energy density, such as NdFeB magnets, SmCo magnets.

Since the three-phase motor 4 (41; 72, 73) will be utilized for an utmost short intermittent operation having very long rest times, it may be designed for effects corresponding to an overload of 8 to 50 times, such as 15 to 20 times.

All parts or only selected parts 42b, 43c and 43d in the embodiment according to fig. 6 may be produced by means of pressed iron powder.

All parts or only selected parts 74b, 75b, 75d′ in the embodiment according to fig. 8 may be produced by means of pressed iron powder.

Parts manufactured of pressed iron powder provide a lower permeability than solid iron material and provide in that connection a contribution to a lower inductance value, but give for this application insignificant higher losses.

With a renewed reference to fig. 2, it is shown that the control circuit 20 and the motor 4 are co-ordinated is such a way via the module 20b that rotor (42) and stator (43) should be able to assume an adapted mutual position, where opportunities have been created for generating a high torque that is proportional to the initial current supply having a high current derivative in respect of time.

In the construction of the three-phase motor, the practical application indicates that the air gap may be selected to a value that at all events is below 3 mm or to a value above 0,5 mm at press-casted details.

Here, it should be advantageous to more particularly choose the air gap to a value between 0,7 and 1,4 mm.

The number of turns in the stator belonging to the three-phase motor is, at all events, selected to be below 40 but should in the practical application exceed 2-4 turns per phase.

The number of turns in the stator and when using a nominal operating voltage of below 50V DC is selected to be below 40.

Each one of said permanent magnets is allotted the form of a part of a hollow cylinder and where all permanent magnets are oriented side by side according to what is shown in the figures in order to form said hollow-cylindrical shape.

The permanent magnets are fixedly related to an inner surface portion of a hollow-cylindrical ring, surrounded by the permanent magnets, where the ring may consist of an iron or steel material.

The ring consists of a pressed and/or in another way produced iron pow-

der material and/or steel material.

The radial thickness of the ring should, in the practical application, be set at a selected ratio to the radial thickness of the permanent magnet.

In fig. 6, it is suggested that a ratio between the radial thickness of the ring should have values between 2,0 and 1,0, such as about 1,3.

In fig. 8, it is suggested that a ratio between the radial thickness of the ring and the radial thickness of the permanent magnets should have values between 1,0 and 5,0, such as about 3,0.

Each one of a number of permanent magnets, included in a motor having an inner rotor, is allotted the form of a part of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to form said complete hollow-cylindrical shape.

The permanent magnets are fixedly related to an outer surface portion of a hollow-cylindrical ring clamping the permanent magnets, where the ring may consist of an iron or steel material.

The ring consists of a pressed and/or in another way produced, such as extruded, iron powder material and/or steel material.

Said three-phase motor is here divided into two motor units, arranged electrically parallel, one on each side of said reel.

It is suggested that the chosen short time load is based on three short maximal torque outputs within a duration of less than 5 min, where the maximal torque output should be limited to 0,5 s.

The three-phase motor 4 may, via mechanical gear equipment, be in co-operation with a reel.

This embodiment is shown more in detail in fig. 9, where a perspective view illustrates that the motor 4 is attached to a holder 90, through which a shaft 91 extends, included as a shaft of the motor 4. To the shaft 91, a gear wheel 91a is attached, which in turn acts on a gear wheel 91b.

On the same shaft as the gear wheel 91b, an additional gear wheel 91c acts, which in turn acts on a gear wheel 91d.

The gear wheel 91 acts, by a coupling, on the same shaft that drives the reel 40, provided with fastening members for the tape and the part 2d.

Here, it is suggested that the three-phase motor 4 and the reel 40 are oriented as branches in a U-shaped unit, with the gear equipment 91, 91a, 91b, 91c

and 91d as well as the holder 90 connecting said branches.

A three-phase motor 4 is here constructed for a high number of revolutions and receives in that connection a more compact construction than if it would be designed for a lower number of revolutions, where the chosen high number of revolutions should exceed 2 000 revolutions per minute.

Furthermore, said three-phase motor 4 is designed without needing to take into consideration requirements being otherwise usual of having low iron losses.

The high torque density is chosen to exceed 8 Nm/kg.

The upper limit is here chosen somewhat below a set demagnetisation limit of utilized permanent magnets.

Said three-phase motor is allotted a reduced slot insulation within the stator, for an increase of the winding area and the filling ratio within the stator.

The stator may be moulded and/or injection moulded from a powder material in order to, in doing so, increase the filling ratio of the windings in the stator, especially by said production method offering smooth surfaces, which then can accept thinner insulation layers at the same time as the low operating voltage does not require a thick insulation layer.

Furthermore, it is disclosed that as winding wire a wire section should be utilized of high packing degree, such as a wire having a right-angled cross-section.

The desired high torque density is based on a chosen current load upwards approaching 1 200–2 500 A/cm.

The force density is chosen to between 0,1–0,3 N/mm^2 air gap surface.

With a reference to fig. 10, there a stator tooth is shown in cross-section, corresponding to the stator tooth 43d (the embodiment A) formed of iron laminate having a concentric winding and where it is seen that between the winding and the laminate air gaps 101, 102 are present. Iron laminate requires, by the uneven shape thereof, quite thick insulating material 103 between the stator tooth and the winding 43b.

With a reference to fig. 10, there a stator tooth 43d (the embodiment B) is shown in a section formed of an iron powder material and having a concentric winding 43b and where it is seen that here may the entire stator end be formed so that the winding 43b closely surrounds the rounded end portions 431, 432 and entirely covers the air gaps 101, 102 outlined in the embodiment A.

This embodiment (Fig. 10B) offers the advantage that also the coil ends on the stator winding may be utilized in order to generate the desired torque, as it has turned out to be possible to have the coil ends in the stator filled up by iron powder, such as for concentrically wounded stators, made of iron powder material, which has been pressed or formed in another way.

It is evident that by this stator design, the utilization of the copper conductors is increased in comparison with a laminated stator.

Furthermore, this means that the slot insulation 103 can be made thinner as no consideration is required of abrasion damage on the insulation since the surfaces becomes smoother in a powder pressed or formed material than at a laminated material.
The slot insulation may also be made very thin when the voltage is low and for certain applications it may be enough to only utilize the wire insulation.

Any requirements of having the motor construction designed for high efficiency are not of present interest since the motor is not intended for continuous operation.

The invention is of course not limited to the embodiment stated above as example mentioned but may go through modifications within the scope of the general idea according to the invention illustrated in the subsequent claims.

Claims

1. Arrangement related to seatbelts adapted to a vehicle, having at all events two securing points, intended for the belt, which points are related to a chassis belonging to the vehicle, at all events one of the securing points belonging to the belt consisting of a reel, drivable by an electric motor, in order to being able to reel belt sections or parts near the securing points thereon in order to be able to hold belt stretchings stretched against a person's chest and/or trunk portion or vice versa, one or more sensors being adapted to, at a value occurring above a selected value limit, let said electric motor be activated to drive the reel in a direction in order to increase the stretching force in said belt, and said electric motor consisting of a polyphase motor, characterized in, that said polyphase motor is designed to have an electric inductance that is below 0,4 mH in order to thereby be able to relatively quick provide a high torque, as well as have an overload-related torque density, which is above 8 Nm/kg, in order to obtain a small volume of the motor, which overload can be allowed by virtue of the motor being intended for intermittent operation conditions.

2. Arrangement according to claim 1, characterized in that said polyphase motor is designed with a relatively large magnetic air gap.

3. Arrangement according to claim 2, characterized in that the magnetic air gap is selected to a value that exceeds 8 % of the air gap radius.

4. Arrangement according to claim 1, characterized in that said polyphase motor is designed with permanent magnets in the rotor.

5. Arrangement according to the preceding claims, characterized in that each one of said permanent magnets is allotted the form of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to form said hollow-cylindrical shape.

6. Arrangement according to the preceding claims, characterized in that the permanent magnets are fixedly related to an inner surface portion of one hollow-cylin-

drical ring, surrounded by permanent magnets.

7. Arrangement according to the preceding claims, characterized in that the ring consists of an iron or steel material.

8. Arrangement according to claim 6, characterized in that the ring consists of a pressed and/or in another way formed iron powder material and/or steel material.

9. Arrangement according to any one of the preceding claims 4 to 8, characterized in that said polyphase motor is designed as an outer rotor machine, where the peripheral surface of the rotor is adapted to serve as a reel for belt parts.

10. Arrangement according to claim 1, characterized in that each one of a number of permanent magnets, included in a motor having an inner rotor, is allotted the form of a part of a hollow cylinder and where all permanent magnets are oriented side by side in order to form said hollow-cylindrical shape.

11. Arrangement according to the preceding claims, characterized in that the permanent magnets are fixedly related to an outer surface portion of a hollow-cylindrical ring clamping permanent magnets.

12. Arrangement according to the preceding claims, characterized in that the ring consists of an iron or steel material.

13. Arrangement according to claim 11, characterized in that the ring consists of a pressed and/or in another way formed, such as extruded, iron powder material and/or steel material.

14. Arrangement according to claim 1, characterized in that said polyphase motor is divided into two motor units, arranged electrically parallel, one on each side of said reel.

15. Arrangement according to claim 1, characterized in that a control circuit is adapted to let the rotor and the stator be allotted such a mutual orientation that an

applied current provides a maximised torque or a substantially maximised torque.

16. Arrangement according to claim 1, characterized in that said polyphase motor has a rotor and/or a stator, having selected parts consisting of pressed or in another way formed iron powder.

17. Arrangement according to claim 1, characterized in that said polyphase motor has a rotor and/or a stator having selected parts consisting of a hollow-cylindrical iron material (steel material).

18. Arrangement according to claim 1, characterized in that said polyphase motor is designed for a short time load under specifically defined conditions.

19. Arrangement according to preceding claim, characterized in that the chosen short time load is based on a maximised number of, such as three, short maximal power outputs within a duration determined in advance, such as below 5 min.

20. Arrangement according to claim 18 or 19, characterized in that the maximal power output or torque output is limited to a duration chosen in advance, such as 0,5 s.

21. Arrangement according to claim 1, characterized in that the polyphase motor is, via mechanical gear equipment, in co-operation with the reel.

22. Arrangement according to the preceding claims, characterized in that the polyphase motor and the reel are oriented as branches in a U-shaped unit with the gear equipment connecting said branches.

23. Arrangement according to claim 1, characterized in that said polyphase motor is constructed for a high number of revolutions and get, in that connection, a compact construction.

24. Arrangement according to the preceding claims, characterized in that the chosen high maximal number of revolutions is adapted to exceed 2 000 revolutions

per minute.

25. Arrangement according to claim 1, characterized in that said polyphase motor is designed regardless of occurring iron losses.

26. Arrangement according to claim 1, characterized in that the high torque density is chosen to exceed 8 Nm/kg.

27. Arrangement according to claim 1 or 26, characterized in that an upper limit of the torque density is chosen somewhat below a set demagnetisation limit of utilized permanent magnets or somewhat below a thermal limit of the winding insulation.

28. Arrangement according to claim 1, characterized in that said polyphase motor is allotted a reduced or removed slot insulation within the stator, for an increase of the winding area and the fill factor in the slot within the stator.

29. Arrangement according to claim 1, characterized in that the stator is pressed and/or shaped of a powder material in order to, in doing so, increase the fill factor.

30. Arrangement according to the preceding claims, characterized in that a wire cross-section of a high packing degree is utilized as winding wire, such as a wire having a right-angled cross-section.

31. Arrangement according to claim 1, characterized in that power density or the torque density is based on a chosen current load upwards approaching 1 200–2 500 A/cm.

32. Arrangement according to claim 1, characterized in that the force density is chosen to between 0,1–0,3 N/mm^2 air gap area.

33. Arrangement according to claim 1, characterized in that one or more sensors are adapted to detect obstacles by braking or retarding the vehicle and/or stretching one or more belt parts.

34. Arrangement according to claim 1, characterized in that one or more sensors are adapted to detect motions attributed to the vehicle, within a three-dimensional motion pattern.

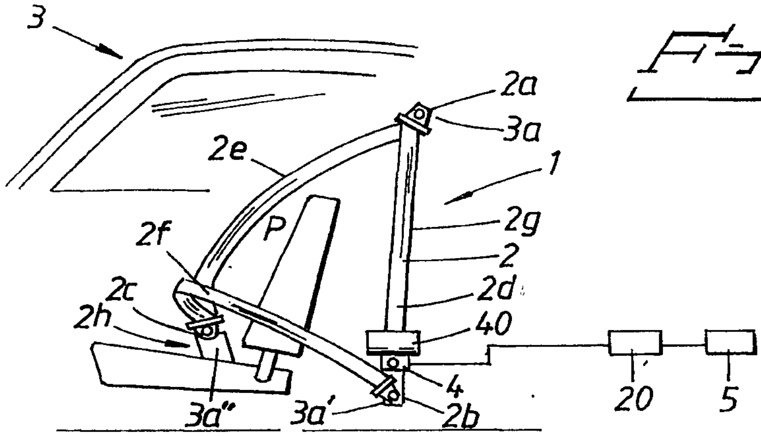


Fig. 1

Fig. 2

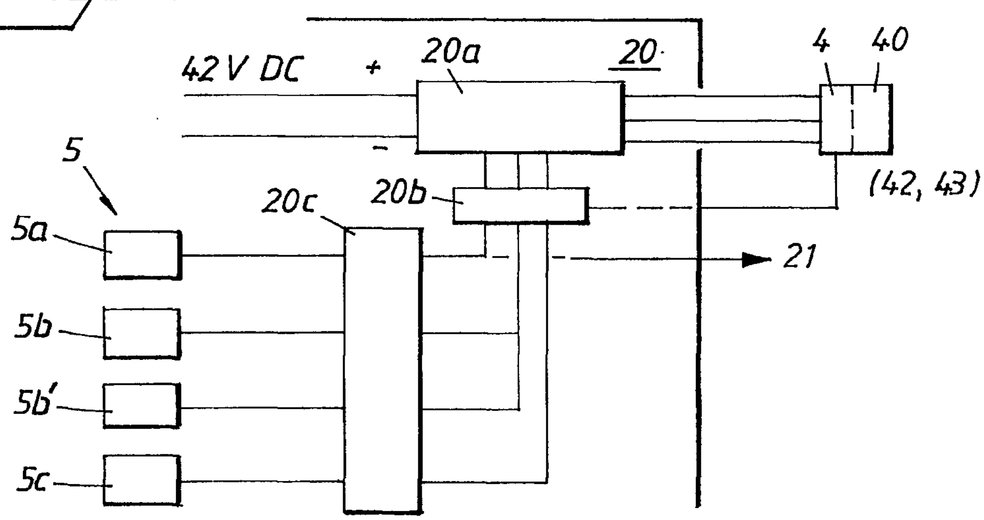
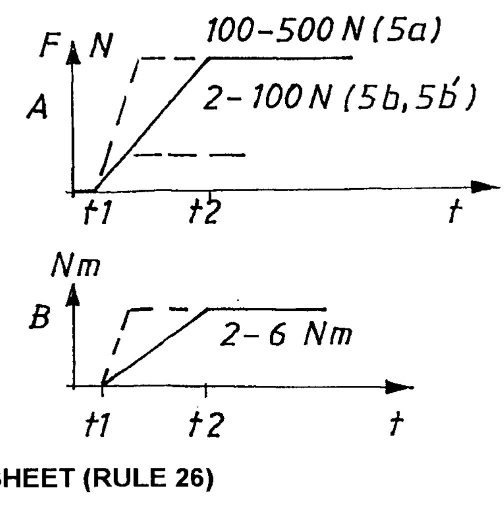


Fig. 3



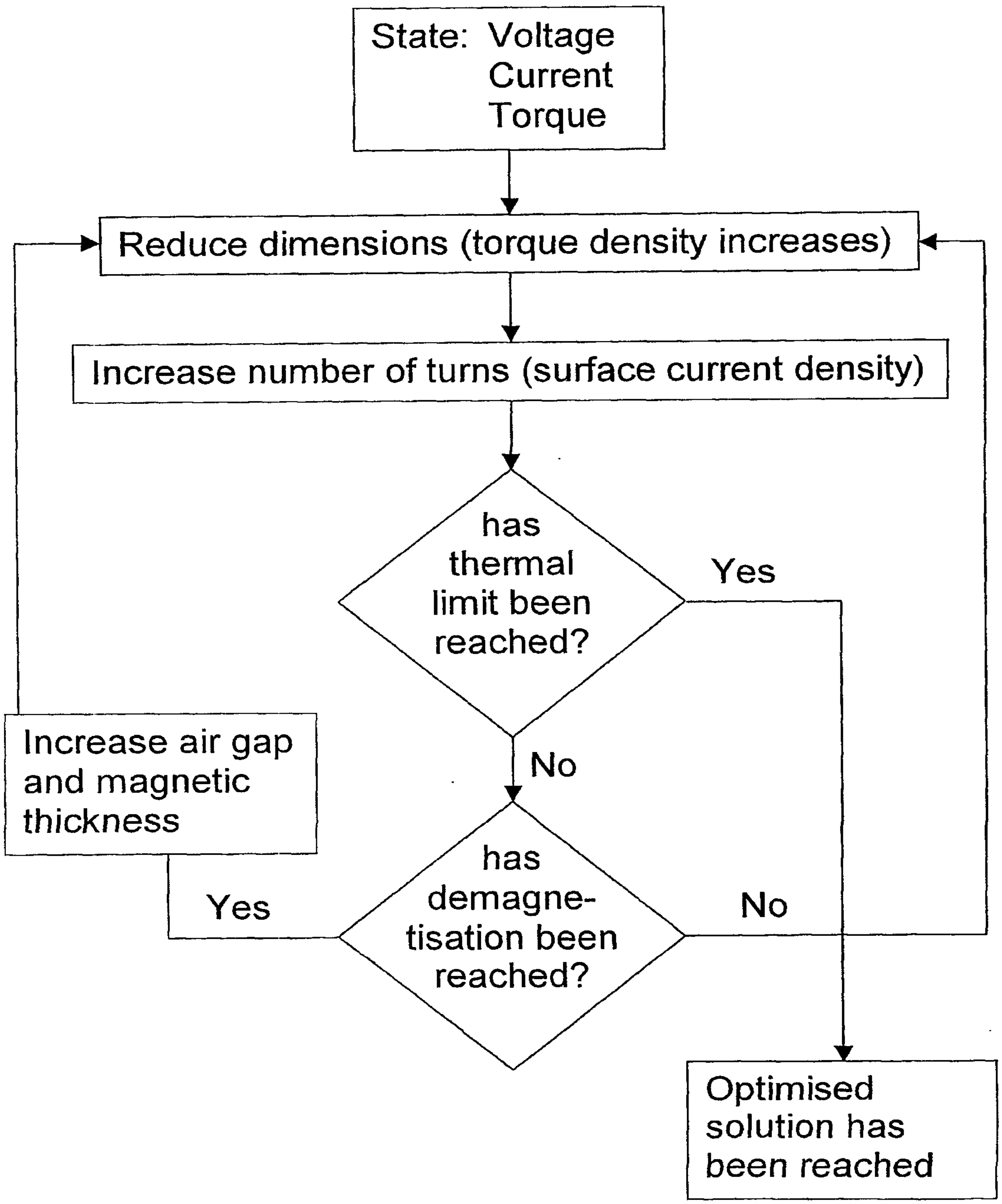

State: Voltage
Current
Torque
Reduce dimensions (torque density increases)
Increase number of turns (surface current density)
has thermal limit been reached?
Yes
No
has demagne-tisation been reached?
Increase air gap and magnetic thickness
Yes
No
Optimised solution has been reached

Fig. 2B

Fig-4

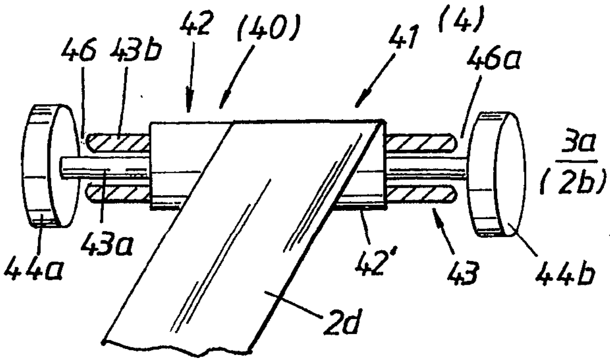


Fig-5

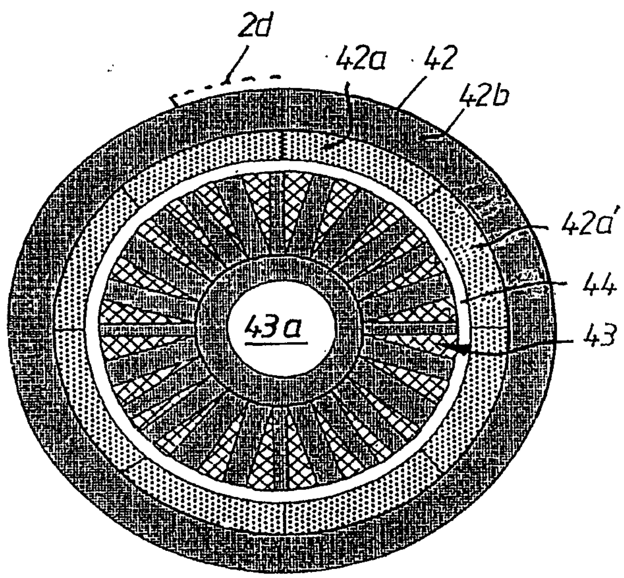


Fig-6

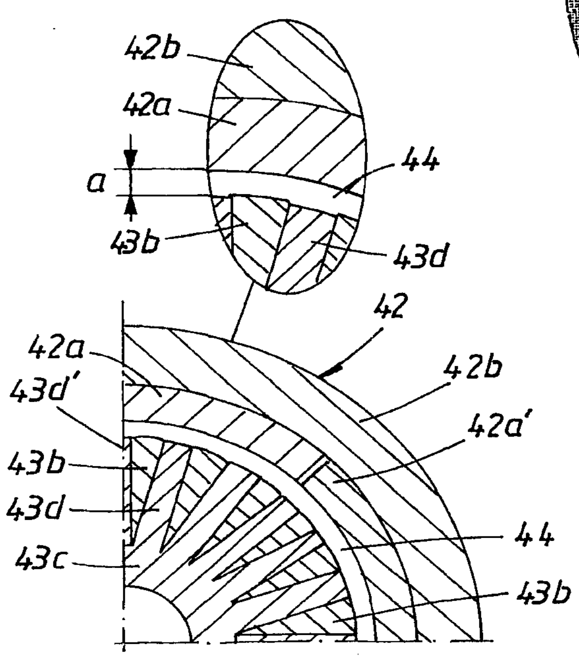


Fig. 7

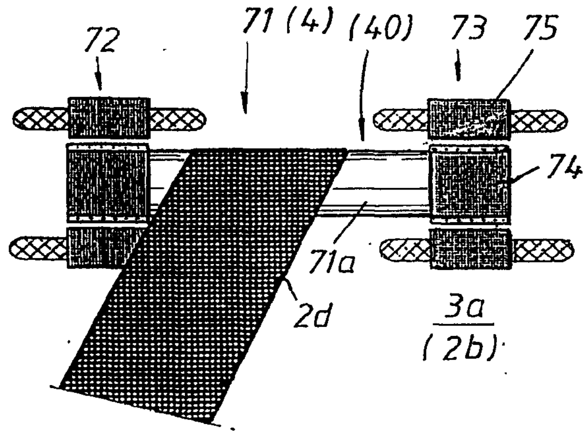


Fig. 8

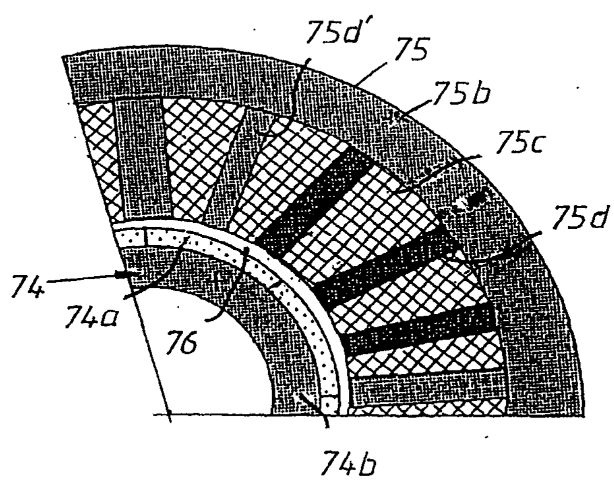


Fig. 9

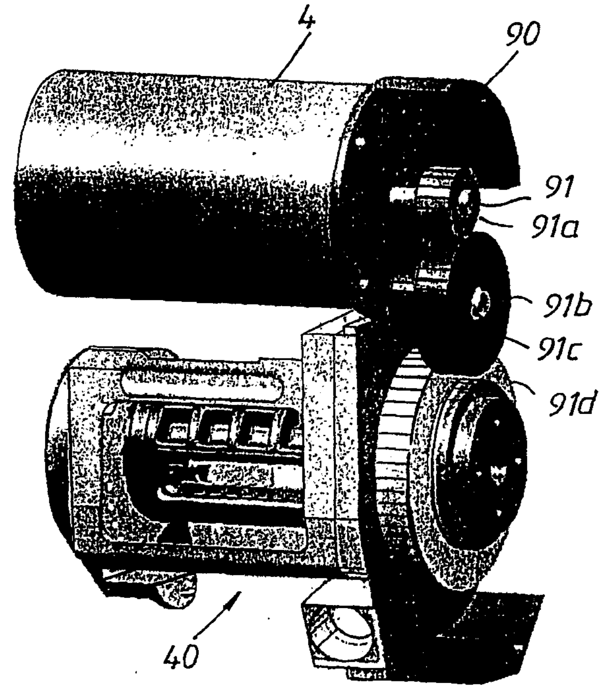
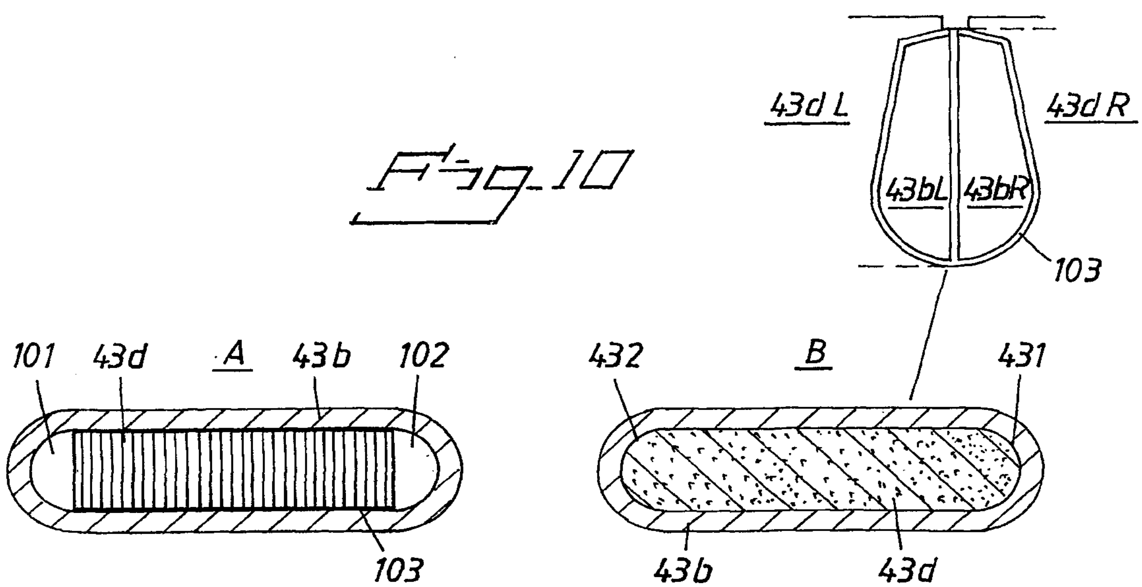

4
90
91
91a
91b
91c
91d
40

Fig. 10


43d L
43d R
43bL
43bR
103
101
43d
A
43b
102
103
432
B
431
43b
43d

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00017

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 22/46, H02K 21/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60R, H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9951469 A1 (STRIDSBERG INNOVATION AB), 14 October 1999 (14.10.99), page 4, line 26 - page 6, line 14	1
Y		2-3
	--	
Y	US 5619085 A (DANIEL J. SHRAMO), 8 April 1997 (08.04.97), column 1, line 20 - column 2, line 30	2-3
	--	
Y	US 4645961 A (HERBERT MALSKY), 24 February 1987 (24.02.87), column 1, line 13 - column 2, line 4	2-3
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 April 2002	30-04-2002

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer
Håkan Sandh/MN
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00017

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5781609 A (DIETER GERLING), 14 July 1998 (14.07.98), column 1, line 50 - column 3, line 11 --	2-3
A	GB 2020915 A (KOLLMORGEN TECHNOLOGIES CORPORATION), 21 November 1979 (21.11.79), page 1, line 10 - line 41 -- --------	1-3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00017

Box I — Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-34 in part
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

See next page

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II — Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Present claims 1-34 relate to a safety belt arrangement defining a polyphase motor by reference to the following parameters:
P1: the motor having an inductance lower than 0,4 mH and
P2: an overload-related torque density higher than 8 Nm/kg.
The use of these parameters in the present context is considered to lead to a lack of clarity within the meaning of Article 6 PCT. It is impossible to compare the parameters the applicant has chosen to employ with what is set out in the prior art. The lack of clarity is such as to render a meaningful complete search impossible.

Furthermore it is not clear from the description in what way the invention differs from the usual measures the person skilled in the art takes into consideration when designing a motor in order to gain the desirable properties. Neither is it clear which measures are necessary for achieving these properties. The lack of clarity of claim 1 makes the novelty of the invention according to claim 1 questionable and due to the fact that at least 19 claims are directly dependent on claim 1 the question of non-unity of invention arises for these claims.

Consequently, the matter for which protection is sought is so unclear that a meaningful complete search is not possible. The novelty search has been directed towards location of documents expressly disclosing polyphase motors having low inductance, large air-gap and high starting torque. The search covers, in part, claims 1-3.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 02/00017

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
WO	9951469	A1	14/10/99	AT	209042	T	15/12/01
				AU	737065	B	09/08/01
				AU	3857899	A	25/10/99
				AU	8250698	A	25/01/99
				DE	69803298	D	00/00/00
				EP	1007085	A,B	14/06/00
				SE	1007085	T3	
				EP	1070005	A	24/01/01
				NO	20000007	A	06/03/00
				SE	9801261	D	00/00/00
US	5619085	A	08/04/97	US	5425165	A	20/06/95
				EP	0505476	A	30/09/92
				JP	5505299	T	05/08/93
				US	5200661	A	06/04/93
				WO	9109449	A	27/06/91
US	4645961	A	24/02/87	NONE			
US	5781609	A	14/07/98	DE	19621707	A	26/06/97
				EP	0780876	A	25/06/97
				JP	9190787	A	22/07/97
GB	2020915	A	21/11/79	AU	4569579	A	15/11/79
				CH	652257	A	31/10/85
				DE	2918493	A	22/11/79
				FR	2425755	A,B	07/12/79
				GB	2110123	A,B	15/06/83
				IE	48332	B	12/12/84
				IT	1163996	B	08/04/87
				IT	7948977	D	00/00/00
				JP	1921898	C	07/04/95
				JP	6028499	B	13/04/94
				JP	54147404	A	17/11/79
				NL	7903619	A	12/11/79
				US	4228384	A	14/10/80